(12) UK Patent Application (19) GB (11) 2 155 729 A

(21) Application No 8503738

(22) Date of filing 14 Feb 1985

(30) Priority data

(31) 8405947   (32) 7 Mar 1984   (33) GB

(71) Applicant
Quantel Limited, (United Kingdom),
Kenley House, Kenley Lane, Kenley, Surrey, CR2 5YR

(72) Inventors
Paul Roderick Noel Kellar,
Robin Alexander Cawley,
Neil Roy Hinson

(74) Agent and/or address for service
Matthews, Haddan & Co., Haddan House, 33 Elmfield
Road, Bromley, Kent, BR1 1SU
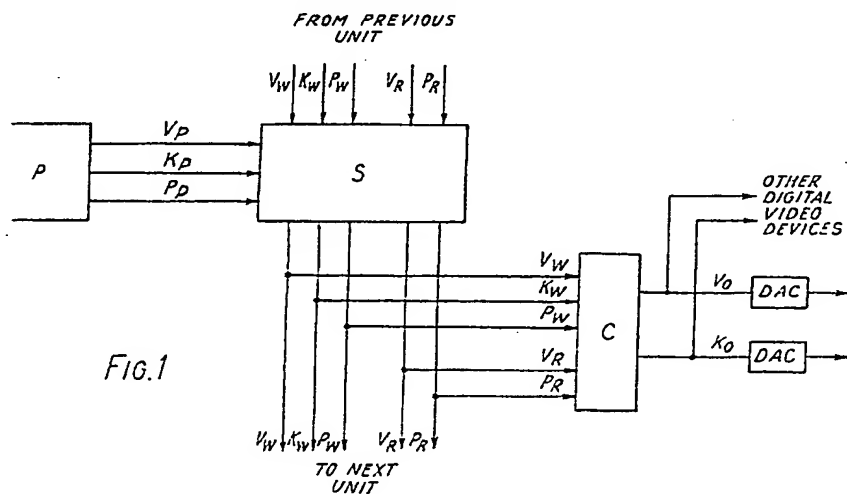
(51) INT CL^4
H04N 5/272

(52) Domestic classification
H4F D12X D22 D24 D2A D2B D30K GJ

(56) Documents cited
None

(58) Field of search
H4F
H4T

(54) Video signal combining system

(57) In a video signal processing system a number of video image signals are combined to provide an output which is such that where several objects of the input images overlay they appear to be at different distances. Each input video signal V is provided with a priority signal P and a series of contests are held within the processor so that the final image consists of the two video signals with the highest priority. A key signal K is provided for the video signal with the highest priority. The processor comprises a series of selectors S which receive a plurality of video signals V_w, V_r from the previous selector and an input video signal V_p. The selector chooses the signals with highest priority P_w, P_r for transmission to the next selector. A combiner C combines the final signals according to the key signal K_w associated with the highest priority video signal.
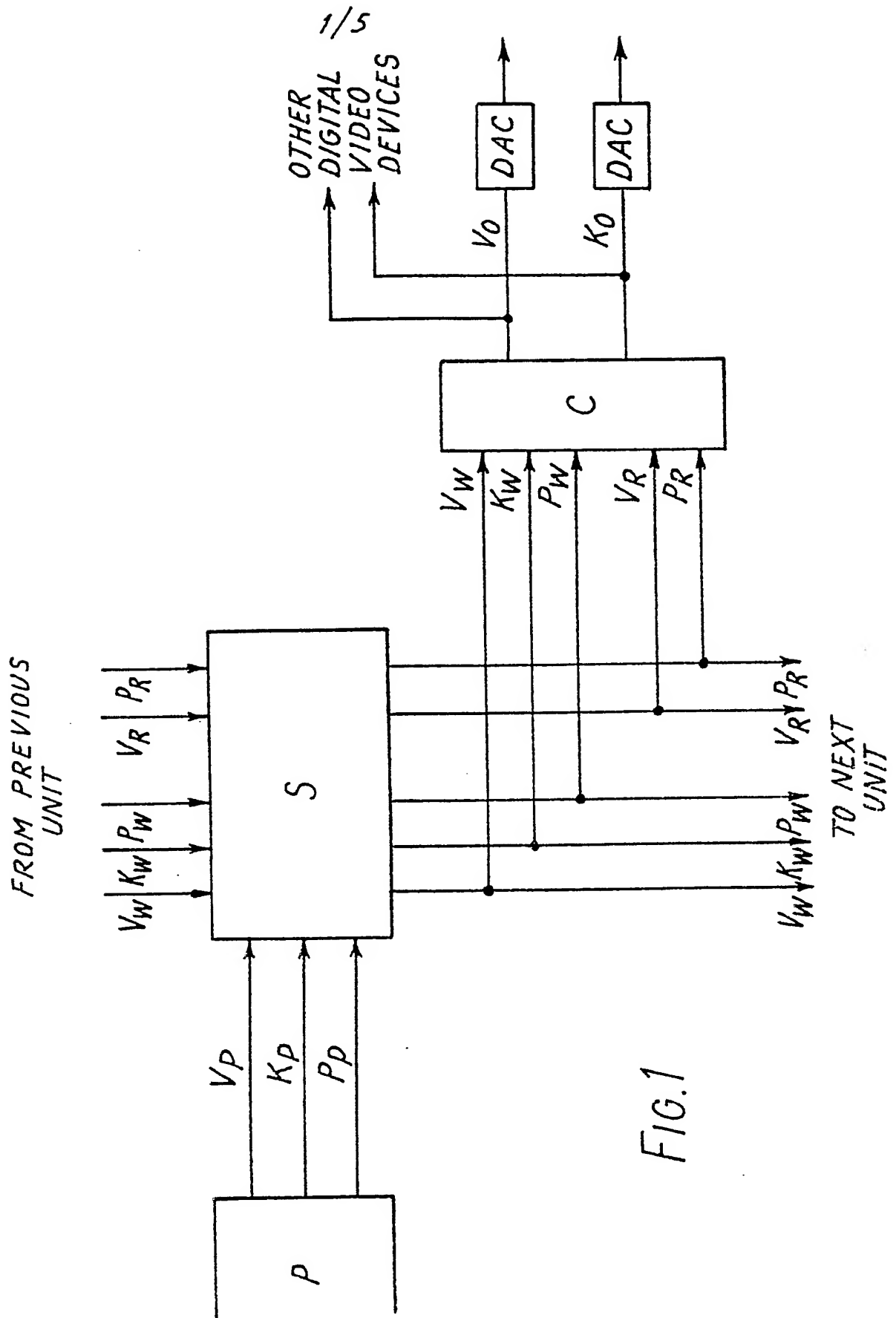

FIG.1

8155720

FROM PREVIOUS UNIT

V_W K_W P_W V_R P_R

V_P
K_P
P_P

P

S

OTHER DIGITAL VIDEO DEVICES

C

V_W
K_W
P_W
V_R
P_R

V_0 DAC

K_0 DAC

V_R P_R

TO NEXT UNIT

V_W K_W P_W

FIG.1

8155730

FIG.2

$FIG.\ 3$

2155730

FIG.4

2155780

$X_1 \ (V_1 \ P_1 \ K_1)$

A.

t_0 t_ℓ

TIME	t_0	t_1	t_3	t_ℓ
WINNER VIDEO	R	V_1	R	
WINNER PRIORITY	0	P_1	0	
WINNER KEY	0	K_1	0	
RUNNER UP VIDEO	R	R	R	
RUNNER UP PRIORITY	0	0	0	

B.

t_0 t_ℓ

$X_2 \ (V_2 \ P_2 \ K_2)$

FIG. 5

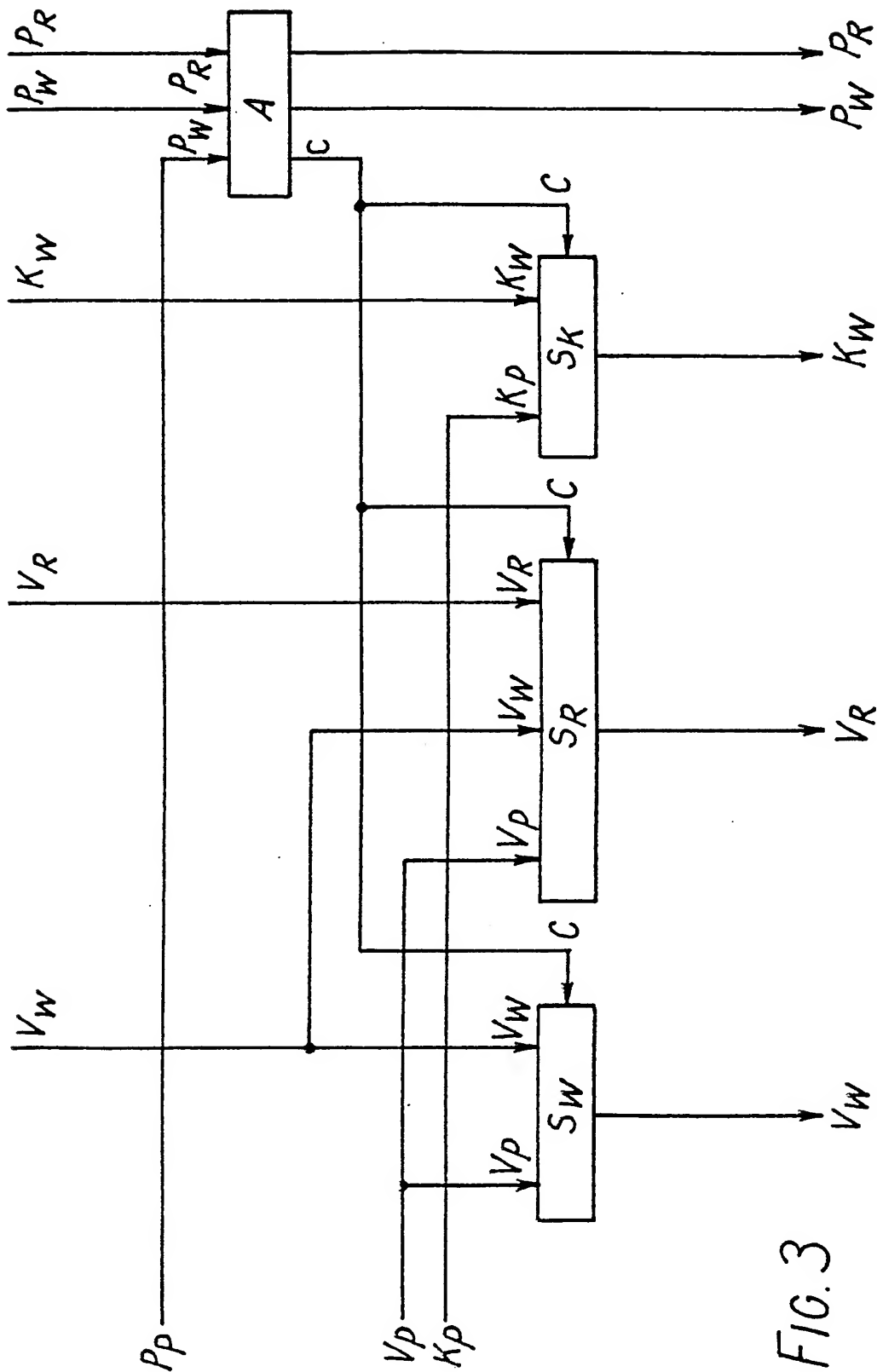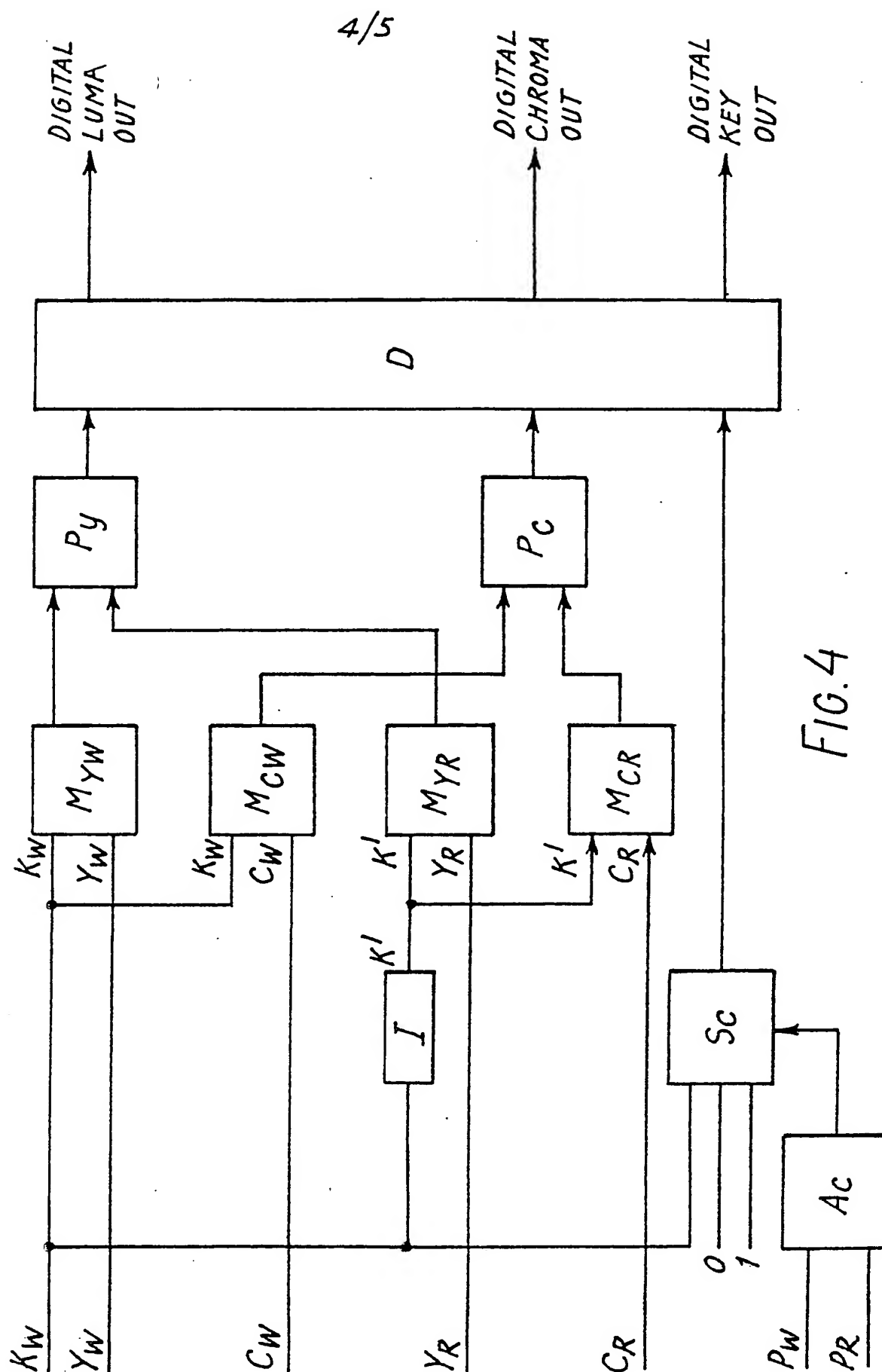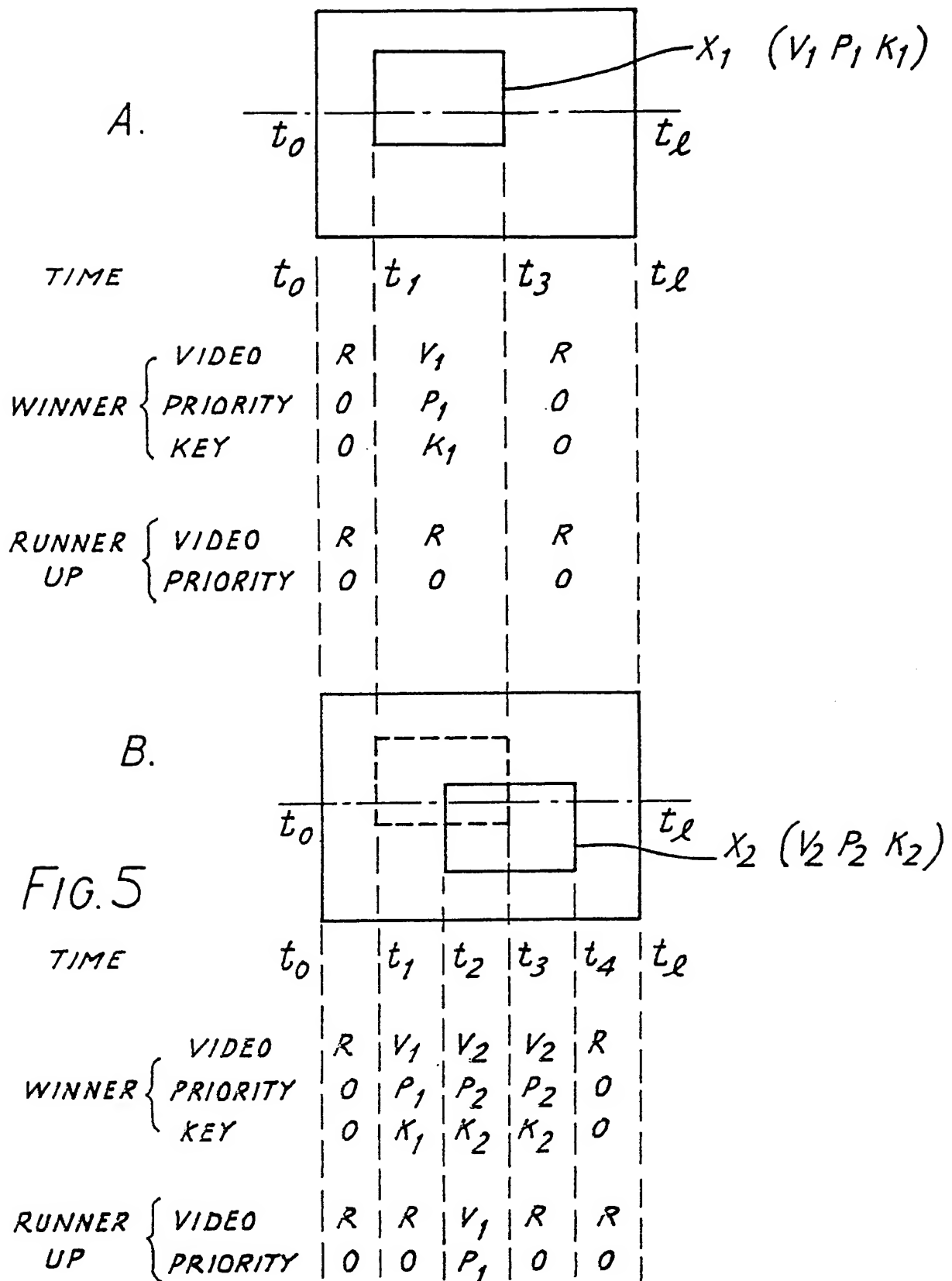| TIME	t_0	t_1	t_2	t_3	t_4	t_ℓ
WINNER VIDEO	R	V_1	V_2	V_2	R	
WINNER PRIORITY	0	P_1	P_2	P_2	0	
WINNER KEY	0	K_1	K_2	K_2	0	
RUNNER UP VIDEO	R	R	V_1	R	R	
RUNNER UP PRIORITY	0	0	P_1	0	0	

SPECIFICATION
**Improvements in or Relating to Video Signal
Processing Systems**

Background to the Invention
5   This invention relates to video signal processing
systems, in particular systems in which the
processing is carried out on digital video signals.
    Devices for processing digital video signals are
widely used in television broadcasting and in other
10 situations for producing special effects in pictures
reproduced from the processed signals. Such
devices are, for example, the digital production
effects machines known as the DPE 5000, digital
library systems such as the DLS 6000, or video
15 generating systems such as the DPB 7000, all of
which are articles of commerce manufactured by
Quantel Limited of Kenley House, Kenley, Surrey,
England.

Object of the Invention
20   The object of the present invention is to provide a
video signal processing system in which the outputs
of a number of digital video devices each capable of
generating an independent sequence of digital
video signals representing an image can be
25 combined in such a way as to provide a video signal
output in which the image produced at points where
several objects of the input images overlap is such
that they appear to be at different distances from the
screen.

30 Summary of the Invention
    According to the present invention there is
provided a video signal processing system
comprising a plurality of processing stages each
capable of providing a sequence of digital video
35 signals and associated priority signals relating to a
respective image, a selector for each stage arranged
to transmit to the next selector a plurality of
sequences of digital video signals and priority
signals selected from the group which consists of
40 the video signals and priority signals provided by
the stage and then transmitted from the preceding
selector, the selection of the video signals in the
sequence being dependent upon the priority signals
in the group, and means for combining the video
45 signals transmitted to the last selector to produce a
sequence of output video signals.
    The initial selector has means for providing
reference video and priority signals, in the place of
video and priority signals which would otherwise be
50 transmitted from a preceding selector: preferably
moreover a sequence of key signals is provided in
association with the sequences of video signals
provided at each stage, and each selector is
arranged to transmit to the next selector the key
55 signals associated with the video signals of highest
priority. The key signal is preferably such that when
combining of video signals occurs, linear keying is
achieved whereby one image object is made to
overlap another of lower priority cleanly by
60 generating an area at the edge of the top object in
which the output signals are produced by mixing
together the video signals representing the two

images involved in proportions determined by the
key signal. The use of key signals is described in our
65 co-pending Patent Application No. 8300378, the
disclosure of which is incorporated herein by
reference. The image generated using key signals
corresponds much more closely to the real world
than those produced by switching sources between
70 picture points.

Brief Description of the Drawings
    In order that the present invention may be more
clearly understood and readily carried into effect, it
will now be described more fully with reference to
75 the accompanying drawings in which:—
    Figure 1 illustrates one unit of a system according
to one example of the invention, the unit comprising
one processing stage, a selector and a combiner.
    Figure 2 illustrates a plurality of such units linked
80 together to provide a system capable of producing a
composite image.
    Figure 3 illustrates the selector of Figure 1 in
greater detail.
    Figure 4 illustrates a combiner in greater detail.
85   Figure 5 comprises diagrams explanatory of the
operation of Figure 2.

Description of Preferred Embodiments
    Each video device is assumed to produce as an
output three sequences of digital signals timed by a
90 common clock, namely, Video, Key, and Priority.
The Video (marked V) represents the digitised image
presented at a given selector, and may be in any
color-separated format. For the remainder of this
discussion a format consisting of 8 bits of luminance
95 data (Y) and eight bits of alternating color difference
data (U/V) is assumed. The Key (K) is a fractional
signal in the range 0 to 1 which has the value 0
where the video image is maximum, and ramps
smoothly between these values at the edges of the
100 image. It is assumed for the purpose of this
discussion to be an 8 bit binary fraction, though
fewer bits are adequate for many applications. The
Priority (P) is an arbitrary depth code designating
the depth plane which the object is intended to
105 occupy in the output image. The value 0 is assumed
to be the lowest priority (most distant, or
background, plane). The priority will be constant if
the video provided by a particular device is intended
to represent a single object. A generalisation to
110 allow a single video device to generate video
representing multiple objects or different depths is
discussed below. The video device may be for
example of a digital production effects machine DPE
5000. It will be understood that there is a digital
115 Video, Key and Priority signal for each point in a
frame of the image or picture.
    The assumption made for this invention is that for
any single point in the picture there is a maximum
number of separate images which need to be keyed
120 together to produce the desired output. For the
purpose of the rest of this discussion that number is
assumed to be two, though serialisation to a higher
number is discussed below. The general mode of
operation is that the two images to be combined are
125 determined by a series of three way contests. For

each contest a "winner" and a "runner-up" are decided, which pass on to the next contest. When all images have "competed" for a position, the final pair of images can then be keyed together to
5 produce a final digital video output. The keying is, of course, carried out by operating on the respective digital video signals. This output may then be used by other digital devices or fed to a DAC to be reconverted to normal analogue video.
10 In figure 1 the video processor P, for example DPE 5000, generates Video, Key and Priority signals Vp, Kp and Pp. These are fed into the selection unit S. Also fed into S are the cascaded outputs Vw, Vr, Pw, Pr, and Kw from the preceding stage. This unit then
15 generates another set of outputs Vw (winner video), Vr (runner-up video), Pw (priority of winner), Pr (priority of runner up) and Kw (winner key) which can be passed on to successive stages. This output may also be tapped off into the combiner C, from
20 which a combined digital output Vo with associated key signal Ko can be passed on to other devices such as a DAC. Figure 2 shows several units linked together to produce a composite image. In this case, the combiner C is optional for all except the last
25 stage.
Figure 3 is a block diagram of the selector S. The three priority inputs are fed into an arbitrator A. This compares the three numeric values and generates the output Pw and Pr and also a selector control
30 signal C. The arbitrator in this example is implemented by a look-up table, but it may be implemented by other forms of logic circuits. The signal C controls the operation of selectors, Sw, which selects between the inputs Vw and Vp, Sr
35 which selects between Vw, Vc and Vp, and Sk which selects between Kw and Kp. A signal Z is generated from key input Kp, and is asserted only when Kp is exactly zero. When asserted, it forces all three selectors to the state where Sw selects Vw, Sr
40 selects Vr and Sk selects Kw. This means that the cascaded inputs pass straight through if the input key is zero and therefore is to be ignored.
Otherwise the design of A is such that:

45	1. if Pp>Pw then	Sw selects Vp Sr selects Vw Sk selects Kp
	2. if Pw>Pp>Pr then	SW selects VW Sr selects Vp Sk selects Kw
50	3. if Pp<Pr then	Sw selects Vw Sr selects Vr Sk selects Kw

Case 1 occurs when the new channel has higher priority than both inputs and pre-empts the
55 "winner" position and the winner becomes "runner-up". In this case it key also pre-empts the existing key. Case 2 occurs when the new channel "loses" to the winner but "beats" the runner up, in which case its video displaces the "runner-up" only, leaving the
60 key (which is associated with the "winner") unchanged. Case 3 occurs when the new video "loses to" both inputs and is ignored.

It is impossible for Pr to be greater than Pw, and they can only be the same at the start of the chain,
65 when they will both be zero. It is therefore necessary to be able to represent only half the possible combinations of priorities, in encoded format C. If arbitrator A is a look-up table, encoding and decoding are automatically performed by the table.
70 Figure 4 is a block diagram of the combiner C in Figure 1. The signals Vw and Vr are represented in this Figure as the luminance signals Yw, Yr and the chrominance signals Cw, Cr. The Key signal Kw is fed into multipliers Myw and Mcw to produce
75 signals reduced in magnitude proportionally to the Key. Kw is also applied into an inverter I which produces an output K' representing 1-Kw. This is then used to multiply the runner up video in multipliers Myr and Mcr to reduce them
80 proportionally to the inverse of the (winner) key. The luminance and chrominance signals are then separately summed in adder Py and Pc to produce output Video Y0 and C0. The priority signals Pr and Pw are fed into arbitratory Ac which generates a
85 signal controlling a selector Sc such that:

1. if Pw=0	Sc selects 0
2. if Pw>0, Pr=0	Sc selects Kw
3. if Pw>0, Pr>0	Sc selects 1

The resultant output signals must be fed through a
90 variable delay D if the outputs from the combiners are needed to be synchronous, since the successive stages will differ in timing by the amount of delay through each selector S.
In Figure 2 the inputs at the top of the diagram are
95 not connected. A referencing circuit is provided for the first selector S, to produce reference signals such that each P_w, P_r and K_w is zero, and both V_w and V_r represents a background or matte which will appear on the output whenever no video input has
100 been inserted. This will usually be a flat color, though a background image could be used. If the equipment is designed so that such a matte can be used instead of the cascaded input at any of the stages, the system can be divided into groups of one
105 or more adjacent stages which produce a correctly combined image independent of other groups. If the output at the bottom of figure 2 is connected to the input at the top such a group can "wrap around", increasing the flexibility of reconfiguration.
110 However, it is necessary to designate one unit to have a matte input. In order to illustrate the operation of the system illustrated in Figures 2 to 4, assume that the Video provided by processor P, represents an image such as illustrated in Figure 5A,
115 comprising an object X, in a reference background. The video signals for picture points within the boundary of X, are directed as V_1 and those for picture points in the background are directed as R. The priority is P_1 (>0) for the object X, and 0 for the
120 background. The Key is K_1 for the object X_1 and 0 for the background. As already explained, the "winner" Video, Priority and key signals applied to the first selector S_1 are R 0 0 where R represents the background. The runner up Video and Priority
125 signals are similarly R 0. The object X_1 may be, for

example, a scene picked up by a television camera, but reduced in size and offset as depicted by the processor P_1. The Key signal K_1 will ramp from 0 at the boundary of X_1, through a marginal area to 1
5 over the remainder of the area of X_1.

Consider the signals output from the selector during a representative line period t_0 to t_1 represented in Figure 5A. The three-way contest in the selector S_1 will leave the winner and runner up
10 signals unchanged during the intervals t_0 to t_1 and t_3 to t_1 but will insert the signals V_1 P_1 and K_1 in the winner positions during the interval t_1 to t_3, the runner up signals remaining at R 0. These results are shown below Figure 5A.
15 Assume now that the Video provided by processor P_2 represents an image such as illustrated in Figure 5B comprising an object X_2 in a reference background. The Video, Priority and Key for picture points within the boundary of X_1 are denoted as V_2
20 P_2 K_2, of which $P_2 > P_1$. For the background the corresponding signals are R 0 0. The three way contest in the selector S_2 between the winner and runner up inputs from S_z and the "new" input from P_2 produces the results shown below Figure 5b
25 during the representative line period t_0 to t_1. The signals during other line periods can be deduced.

If the winner and runner up signals produced from S_2 are applied to the combiner C_2, consideration of the operation of Figure 4 on the signals occurring
30 during the line period t_0 to t_1 will reveal that the output of combiner will represent the object X_2 superimposed on X_1 where there is overlap, as indicated in Figure 5B, and that linear keying is achieved.
35 If different processors P should provide respective video signals representing different but exactly overlapping objects which pre-empt the winner and runner up positions, the effect of the winner's Key, when combination takes place may produce an
40 undesirable effect. This effect arises because the Key, in participating in the combination will add at the edges of the winning object a proportion of the runner up object which would not be otherwise apparent in the combine picture. The effect can be
45 avoided, however, by modification of the selectors in such a way as to block the selection of a new runner up and retain the old runner up at any picture points for which the Key for the winner and the Key for the potential runner up are both not zero and not
50 1, i.e. both are between 0 and 1.

Alternatively the selection may be blocked when the key for the winner is greater than or equal to the key for the potential runner up and both are not 1.

If more than two video inputs are required from a
55 preceding selector, the design can be generalised for N video signals by adding more selectors in the selector unit S. For a design with N cascaded signals, N video and priority signals and N-1 key signals must be passed between units, and each
60 unit will require N video selectors, the first having two inputs, the second three, and so on up to having 2 to N inputs.

If a processor P in Figure 2 is to present M multiple image objects to the system it does not need to
65 present M separate video, key and priority channels

and to have M separate selectors S. Since only two video signals can be passed on to the next stage of processing, such a multi-object processor can be simplified to appear as two single object processors.
70 Such a processor might be realised as two processor stages as drawn on figure 2. However, a simpler version may be arranged to produce only a single Video and Key with two priorities.

The invention may, of course, take a variety of
75 other practical forms.

CLAIMS
1. A video signal processing system comprising a plurality of processing stages each capable of providing a sequence of digital video signals and
80 associated priority signals relating to a respective image, a selector for each stage arranged to transmit to the next selector a plurality of sequences of digital video signals and priority signals provided by the stage and those transmitted from the
85 preceding selector, the selection of the video signals in the sequence being dependent upon the priority signals in the group, and means for combining the video signals transmitted to a last selector to produce a sequence of output video signals.
90 2. A video signal processing system as claimed in Claim 1, further including means for providing reference video and priority signals to the initial selector.

3. A video signal processing system as claimed in
95 Claim 1, wherein each selector comprises means for selecting to form a first of said sequences of video signals from the individual video signals at successive picture points associated with the highest priority signals at those points and for
100 selecting to form a second of said sequences of video signals from the individual video signals at successive picture points associated with the next highest priority signals the said two sequences being transmitted to the next selector without
105 individual video signals associated with lower priority signals.

4. A video signal processing system as claimed in claim 1, further comprising means for providing a sequence of key signals in association with the
110 sequences of video signals provided at each stage.

5. A video signal processing system as claimed in Claim 3, wherein each selector comprises means for transmitting to the next selector a key signal associated with the video signals included in the
115 final sequence.

6. A video signal processing system as claimed in claim 2, further comprising means for transmitting from each selector to the next selector the key signal associated with the video signals of highest priority.
120 7. A video signal processing system as claimed in Claim 5, in which said means for combining video signals includes multipliers, said multipliers multiplying the key signal and its inverse by respective video signals.
125 8. A method of video signal processing comprising the steps of providing a sequence of digital video signals and associated priority signals relating to a respective image, selecting a plurality of sequences of digital video signals at one stage

and transmitting to a further stage, said selection being dependent upon the priority signals in the group, and combining video signals transmitted to a last selector to produce a sequence of output video 5 signals.

9. A video signal processing system substantially as described herein with reference to the accompanying drawings.